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Military & Aerospace Electronics

ENABLING TECHNOLOGIES FOR NATIONAL DEFENSE

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Countering unmanned systems

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BY **JOHN KELLER**, EDITOR IN CHIEF

Trusted computing: it's not just cybersecurity anymore

The ability to ensure accuracy in real-time, life- and mission-critical computing is one of the most important aspects of embedded computing today. The rise of multicore processors, parallel processing, real-time networking, and precision timing means the hardware and software engineer has a lot more to worry about than cybersecurity to make sure computing results are correct. That's where trusted computing comes in.

This term, as we see it, means that the computer consistently will behave in expected ways, and that computer hardware and software will enforce those behaviors. Because of the importance of the trusted computing discipline, *Military & Aerospace Electronics* is changing the name of its Cyber Security e-newsletter to Trusted Computing. The reason is there are many more aspects of modern, high-performance, complex embedded computing than cybersecurity issues. There's far more to go wrong in today's embedded computing than a cyber hack.

Timing can be compromised, which can bring down a tactical network, the compute chain in multicore parallel processing can get out of sync, an unanticipated computer bug can change results, software upgrades can go wrong, and many other factors can threaten the integrity of computers on which lives and missions depend. There are future errors we haven't even dreamed of, and we need to be ready.

Trusted computing involves a wider universe than cybersecurity and we're trying to cover all the angles, from safety-critical computing to cyber defenses, anti-tamper, precision networking, and more.

Certainly, trusted computing also has a narrower meaning and we're covering that, too. Many in the embedded computing industry understand trusted computing to involve loading hardware with a unique encryption key accessible to the rest of the system. This is crucially important, and our coverage will encompass this discipline.

In short, we view trusted computing as involving any kind of hardware and software architecture, design, tool, algorithm, or anything else that will ensure the validity of computing results. Lives can depend on this, and that's why we take it so seriously.

Anyone in the computing industry supplying mission- and life-critical military systems, this is about you. If your company is involved in trusted computing in any, we want to hear from you. Please e-mail news and product announcements to *jkeller@pennwell.com*.

We're planning a one-day technical conference on trusted computing sometime next year, and we're looking for industry experts to present their views, technologies, products, contracts, and forecasts. You'll be hearing more on this in the next several weeks and months.

As we work up to our one-day technical conference on trusted computing in November 2018, we will be working with industry to nail-down the definition of trusted computing. As part of this process, we'll be sponsoring webcasts in December 2017 and March 2018 to flesh-out how trusted computing influences computer hardware and software.

We realize that there is probably no one company that specializes in every aspect of trusted computing. Instead, we envision an industry pie chart that encompasses trusted computing. The pie chart has separate sectors of the trusted computing industry, and within each sector we see a range of companies with specific bands of relevant expertise.

We want to know how and where you fit into the dynamic trusted computing industry. Sit down with your colleagues and map out where your company plays in trusted computing. At the same time, we'll be focusing our definition of what trusted computing means, what it doesn't mean, and what companies are involved.

Trusted computing: It's not just cybersecurity anymore.

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2017 Technology Innovation Awards announced for aerospace and defense industry

NASHUA, N.H. — The 2017 Technology Innovation Awards from *Military & Aerospace Electronics* and *Intelligent Aerospace* recognize companies offering substantial military and aerospace design solutions. Awards fall into three tiers, ranging from platinum, the highest, to the gold awards, and finally to the silver awards, based on the recommendations of an independent panel of industry judges.

Platinum awards

The SR429/1M ARINC 429 Converter from Applied Avionics Inc. in Fort Worth, Texas, provides avionics databus interfacing capability in a size smaller than one cubic inch. The device is configurable inside a VIVISUN annunciator or push-button switch. This makes it five to eight times smaller than competing black-box signal converters, officials say.

The CTS-6010 tactical radio series communications test and measurement instrument from Astronics Test Systems in Irvine, Calif., combines 16-plus instruments into one tester. It offers fault detection and operational verification of radio communications at all levels of deployment. The CTS-6000 is for field testing, and can reduce testing time and cost, maintenance, and calibration costs, life-cycle ownership costs, and the number of "no fault found" results.

The OpenHPEC Accelerator Suite from the Curtiss-Wright Defense Solutions Division in Ashburn, Va., is an integrated suite of open standards-based tools. Traditional tools in embedded computing applications often cannot support the new programming paradigm of next-generation multi-core CPUs and GPUs. Driven by a large user base, the high-performance computing (HPC) community has created a mature set of software development tools that address shared concerns such as floating-point performance, data throughput, communication latency, and standard APIs.

The RARe Motheye Fiber from Fiberguide Industries in Stirling, N.J., is based on a randomized process that creates nanostructures on the fiber surface to create fiber-optic cables with anti-reflective properties. This procedure helps produce fiber-optic cables with superior wavelength range, durability, and damage thresholds compared with common coated thin-film surfaces.

The CWB 150 FlexPack ballistic safe battery from Inventus Power in Woodridge, Ill., is a flexible power-storage system that meets the U.S. Army's requirements. As the demand for power for dismounted troops grows, the U.S. military is looking for new technologies to supply energy and lighten soldier loads. The proliferation of radios and the introduction of Nott Warrior, an integrated situational awareness and mission control system, are the main reasons for the four-fold increase in power. The extra weight that soldiers must carry as a result of their battery loads is a concern. Troops often lug upwards of 100 pounds of gear, and an infantry platoon carries about 700 pounds of batteries (17 pounds per Soldier) for a 72-hour mission.

The ASURRE-Stor self-encrypting, solid-state drive from Mer-cury Systems in Andover, Mass., blends high-endurance NAND flash with a military-hardened 2.5-inch form factor for mission-critical storage of classified, secret, and top-secret data in accordance with the Commercial Solutions for Classified (CSfC) program's hardware full disk encryption (HWFDE) standards. The ASURRE-Stor SSD is listed on the NSA's CSfC components list, and ready to be integrated into a CSfC two-layer security solution.

The UAV Ground Control Station Avionics Display with Multi-Touch and Gesture Control from a team of Core Avionics & Industrial Inc. (CoreAVI) in Tampa, Fla.; Presagis in Montreal; and Wind River Systems, an Intel company in Alameda, Calif., is a gesture-controlled avionics application based on commercial off-the-shelf (COTS) products. Previously, multi-touch and gestures have been used in electronic flight bags (EFBs), but not those that are installed in aircraft and require certification.

The TTE-Switch Controller Space from TTTech North America Inc.

in Andover, Mass., is an integrated device supporting standard Ethernet, rate-constrained according to ARINC 664 part 7 and time-triggered SAE AS6802 Time-Triggered Ethernet Standard compliant communication. The chip is based radiation-hardened by design process and packaged in a hermetic housing providing the necessary radiation tolerance for use in harsh space environments.

Gold awards

The RS363S15F rugged 3U server for autonomous vehicles from Crystal Group Inc. in Hiawatha, Iowa, is the result of a partnership between Crystal Group and Intel to design a robust, rugged, and reliable high-performance embedded computer for autonomous vehicles, as well as for aerospace and defense, government, industrial, and commercial applications. The main goal was to find existing technologies and products that could be adapted quickly. An additional goal was to find a company that was comfortable working in a dynamic environment with changing requirements while still being responsive with high-quality solutions.

The DTS1 data transport system from Curtiss-Wright Defense Solutions is a compact network-attached storage (NAS) device that can protect classified mission data to certified standards. It has reduced size, weight, and power consumption (SWaP), and offers a hardware layer with full disk encryption using an AES256-bit FIPS-certified ASIC. The use of hardware and software full disk encryption creates a two-layer encryption. This layered encryption approach was a critical requirement for NSA certification.

The Parvus DuraCOR 312 rugged embedded computer from Curtiss-Wright Defense Solutions integrates the NVIDIA Jetson TX2 SOM module with ruggedization to extend native TX2 operation beyond factory

ratings and integrate military and aerospace-specific system capabilities, including avionics databus interface support, 50-millisecond power hold-up, and high-speed PCI Express-based M.2 NVMe storage. This rugged COTS mission computer packs performance with six ARMv8 processor cores and a 256-core Pascal-based GPU. Its NVIDIA CUDA-compatible graphics processor and 64-bit multi-core ARMv8 architecture can satisfy deep learning, parallel processing and high-performance embedded computing (HPEC) demands, while

delivering compatibility with modern virtual machine hypervisors, software routers, and target software applications.

The VPX3-687 3U VPX 10-gigabit/40-gigabit backplane Ethernet switch from Curtiss-Wright Defense Solutions is a high-density 3U VPX Ethernet switch able to implement high-performance embedded processing clusters in a small size. It has support for IEEE standards for backplane Ethernet, and delivers as much as 32 ports of 10 Gigabit Ethernet, or eight ports of 40-Gigabit Ethernet. These provide low-latency control plane for coordination between processors, or a high-throughput pipe for transferring massive amounts of sensor data.

The C4ISR Modular Open Suite of Standards (CMOSS) VPX backplane for the U.S. military's Hardware Convergence Initiative from Elma Electronic Inc. in Alameda, Calif., is a 14-slot 3U OpenVPX backplane that supports the defense industry's hardware- and software-convergence initiatives for modular architectures. It is for modules addressing the DOD's CMOSS for systems optimized for performance, reduced SWaP, and low life-cycle costs for rapid technology insertion. It enables the development of complex, high-speed signal processing systems with the latest fiber and RF connectivity and precision radial network timing plus slot profiles for single-board computers, switches, radial clocks, and expansion.

The ISL72813SEH rad-hard 32-channel driver with integrated decoder from Intersil, a Renesas company in Milpitas, Calif., is a radiation-hardened, high-voltage, high-current, driver circuit fabricated using Intersil's proprietary PR40 silicon-on-insulator process technology to mitigate single-event effects. This device integrates 32 driver circuits that feature high-voltage, common emitter, and open-collector outputs with a 42V breakdown voltage and a peak current rating of 600 milliamps.

The 3DS MEMS Inertial Sensor System Platform from MEI Micro Inc. in Addison, Texas, is a single-chip, tactical-grade six-degree-of-freedom inertial measurement unit (IMU) using a proprietary 3D System MEMS fabrication platform. It is scalable to a Navigation Grade IMU, and can scale to include additional sensors to measure physical phenomena other than motion, such as pressure, magnetic field, and sound, enabling up to a 10-degree-of-freedom sensor or an inertial navigation unit on one chip.

The Spatium solid-state power amplifier from the Qorvo Infrastructure and Defense Products business in Greensboro, N.C., works by combining several MMICs to provide high-power output in a small package. Spatium is a replacement for legacy TWTAs in a variety of applications. It is a single-stage efficient and broadband combining platform.

The Nanopak i7 from Themis Computer in Fremont, Calif., is an Intel Core i7-based rugged computer that packages an Intel 6th generation Core i7 Skylake processor, 32 gigabytes of DDR4 memory, and 1 terabyte of FLASH storage in a small and lightweight form factor.

The GORE Aerospace Ethernet cables from W.L. Gore & Associates Inc. in Newark, Del., are engineered for the increasing data demands of modern airborne digital networks. They exceed Cat6a electrical requirements and deliver signal integrity with sufficient margin for high-speed data transmission as fast as 10 gigabits per second over long distances. The cables are 24 percent smaller and 25 percent lighter than standard Cat6a cables, and on the SAE-AS-6070 Qualified Parts List.

The VxWorks 653 software-design platform from Wind River Systems offers a multi-core ARINC 653 product that delivers an ARINC 653-compliant platform for integrated modular avionics (IMA) applications. VxWorks 653 3.0 Multi-core Edition provides software partitioning in time and space to ensure fault containment in accordance with strict IMA and ARINC 653 requirements. VxWorks 653 Multi-core Edition enables reduced SWaP and reduced bill of materials on advanced aircraft.

Silver awards

The Fortress from Curtiss-Wright Defense Solutions is a combined data,

voice, datalink, and image recorder using a modular architecture to accommodate custom interfaces quickly with low time, cost, and risk overhead. Optional features include data encryption, wireless download, and additional parameter acquisition from ARINC 429, MIL-STD-1553, discrete and analog interfaces.

The VPX56H-6 6U VPX 1000-watt AC/DC power converter from North Atlantic Industries in Bohemia, N.Y., plugs into a standard 6U VPX chassis with a VITA 62 power supply slot. The off-the-shelf solution for VITA 46.0 and VITA 65 systems is compatible with VPX specifications; supports VITA standard I/O, signals, and features; and conforms to the VITA 62 mechanical and electrical requirements for modular power supplies.

The Hyper-Unity from Themis Computer is a turnkey, MIL Spec, SWaP-optimized, hyper-converged infrastructure platform that delivers all-flash performance for virtualized applications at less than half the cost of traditional storage or other hyper-converged platforms.

The RES NT2 from Themis Computer is a rugged computer server designed to bring supercomputing capabilities to users on the tactical edge in a compact, 2U rugged form factor. The RES-NT2-2U system packages two double-width NVIDIA TESLA or GRID GPU accelerators, two Intel E5-2600 v3/v4 series processors with up to 18 cores per socket, 1 terabyte ECC DDR4 2400 MHz memory, optional 100 Gigabit Ethernet, and eight removable front-access drives in a 23-inch rugged chassis.

VectorCAST/Coupling from Vector Software in East Greenwich, R.I., provides data coupling and control coupling verification for C and C++ software source files, mandatory for safety-critical avionics software according to RTCA DO-178B/C.

Military & Aerospace Electronics 2017 Innovation Awards

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UAV Ground Control Station Avionics Display – Multi-Touch & Gesture Control

CoreAVI, Presagis and Wind River have an integrated technology of an interactive Ground Control Station avionics display demonstrating touch and "first-time-use" of gestures within a cockpit setting for ready-for-certification environment. Combining Wind River VxWorks® RTOS foundation with CoreAVI's ArgusCore™ SC Graphics Suite, the applications execute code automatically generated from Presagis' VAPS XT HMI graphics design tool, requiring no code writing.

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GOLD

The most trusted server for autonomous vehicles

Crystal Group RS363S15F is a rugged 3U COTS embedded server powered by Intel CPU and Nvidia GPGPU technologies for real-time sensor fusion, data processing, deep neural networking, and machine learning critical for autonomous vehicles. Supports 44 processing cores and one terabyte of memory; optional liquid cooling; and is able to withstand extreme tactical environments.

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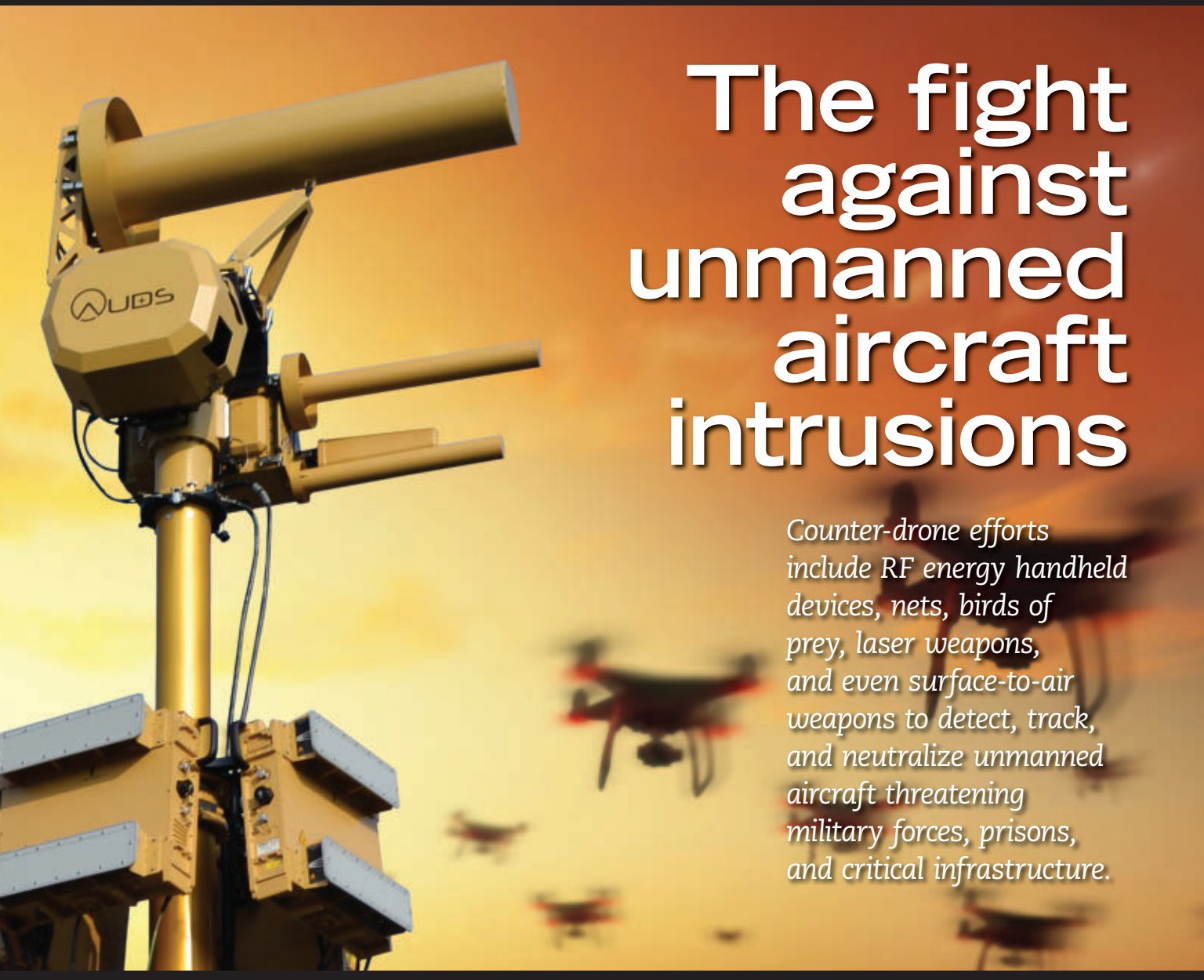

The fight against unmanned aircraft intrusions

Counter-drone efforts include RF energy handheld devices, nets, birds of prey, laser weapons, and even surface-to-air weapons to detect, track, and neutralize unmanned aircraft threatening military forces, prisons, and critical infrastructure.

NOTE: The U.S. government has adopted the generic term UAS—unmanned aircraft system—which includes launch systems and ground control stations. This article deals only with the unmanned aircraft, weapons, software, and sensor payloads, so we are using UAV except in direct quotes.

BY **J.R. Wilson**

One of the best examples of how rapidly advancing technologies can change security requirements is the rise of unmanned aerial vehicles (UAVs). Relatively unknown to all but a few in the military as recently as 1990, today they are central to militaries throughout the world; the general public can even buy them in grocery stores.

The U.S. Federal Aviation Administration (FAA) and its counterparts around the globe have been struggling to define operational limitations on UAV flight parameters, especially around airports, where several apparently accidental incursions already have threatened safe commercial aircraft takeoffs and landings.

The U.S. Secret Service, Department of Homeland Security (DHS), FBI, and military also are installing state-of-the-art sensors and quick-reaction defenses around the White House, U.S. Capitol, Supreme Court, and other federal facilities — domestic and overseas.

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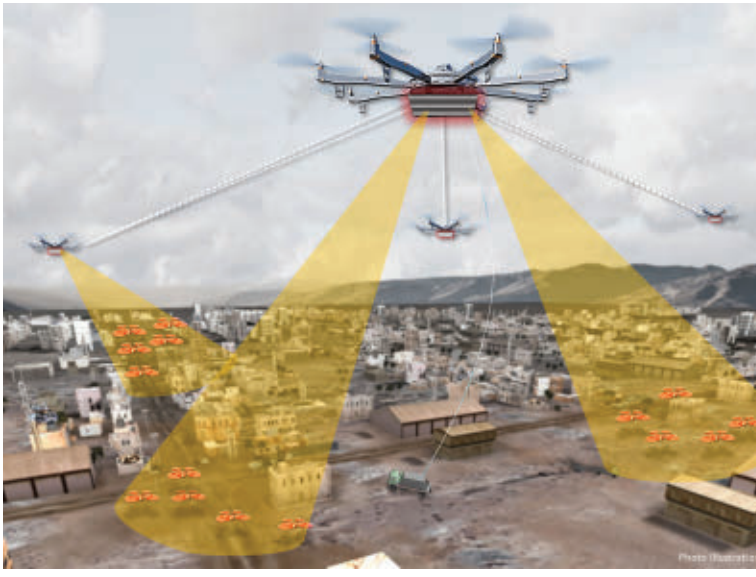
The same applies to port perimeters, major rail heads, critical infrastructure, government buildings, and military bases.

"The FAA works closely with our law enforcement community partners to respond to and investigate UAS incidents and accidents," FAA officials say. "When the operator can be identified, the FAA and the appropriate law enforcement agency work together to investigate the event to determine if any administrative or criminal violations have occurred. FAA works closely with our federal law enforcement, security, and defense partners to share information regarding the risks of possible malicious uses of UAS and consults with them regularly on opportunities to address those risks through regulatory actions and other mitigation measures.

"UAS are a comparatively new, but fast-evolving, technology with operators who are not familiar with aviation or operating aircraft in the National Airspace System [NAS]," FAA officials continue. "In fact, many UAS operators do not recognize they are now part of the aviation system, which leads to a lack of awareness and understanding of their responsibilities for safe operation and the potential risks they can pose by operating unsafely in the airspace."



The Aerial Dragnet from the U.S. Defense Advanced Research Projects Agency seeks to detect several small UAVs in complex and urban terrain before they are within line of sight of U.S. and allied assets.

Originally used by the military for intelligence, surveillance, and reconnaissance (ISR) flights over adversaries overseas, the first weaponized UAV — a CIA-owned General Atomics Predator — took to the air over Afghanistan in October 2001 in support of the post-9/11 U.S. invasion.

In the 16 years since, millions of UAVs, ranging from small, hand-launched ISR platforms to civilian quadcopters to the massive long-range/long-duration Northrop Grumman Global Hawk, have been produced by hundreds of companies and sold to virtually every nation on Earth.

The number of commercial UAVs also has exploded since regulations were relaxed in 2016, when there were 42,000 operating in the U.S. The FAA predicts those platforms — used for everything from agriculture to news gathering — will increase by more than 10-fold by 2021. The speed and size of growth in civilian sectors will depend heavily on future FAA regulatory changes, which have only been a factor for about a decade.

In May 2006, the FAA issued its first certificate of authorization on UAVs, allowing General Atomics M/RQ-1 Predators and M/RQ-9 Reapers to fly in the NAS on disaster search-and-rescue missions. That action came, in part, as a response to Hurricane Katrina the previous year, when requests to use UAVs for SAR were denied

due to a lack of FAA authorization. One Predator sensor that helps make it a formidable weapon of war — an infrared camera, with digitally enhanced zoom, able to identify the heat signature of a human body from an altitude of 10,000 feet — also makes it an ideal SAR tool.

The FAA made registration of small hobbyist UAVs mandatory in 2016; as of March 2017, nearly 800,000 civilian UAVs had been registered — far less than the estimated 1.1 million that had been sold in the U.S. alone by that time. The FAA predicts consumer-owned UAVs in the U.S. will reach 3.55 million by 2021, an annual growth rate of more than 26 percent, but other estimates put that number at 4.55 million.

Counter-UAV programs

The FAA, DHS, FBI, Coast Guard, and local law enforcement are under great pressure to develop better, faster ways to detect even small UAVs. Detection is only the first step, however. Protecting potential targets by stopping the aircraft before they do any harm, whether deliberate or not, is the objective of a wide range of Counter-UAV (C-UAV or C-UAS) programs.

"UAS technology is dynamic — and the systems and technologies that address the potential unsafe or malicious use of UAS will also have to be dynamic," FAA officials say. "Such efforts will likely involve a mix of technologies and regulations associated with requirements that focus on the UAS, the operator and the airspace in which they operate. The interagency approach has led to DHS developing a shared knowledge database helpful in the development of civil detection and mitigation requirements while meeting federal statute and privacy requirements.

"The FAA is committed to working cooperatively with DHS and other government partners to support C-UAS R&D in a manner that is consistent with aviation safety and does not negatively affect the FAA's provision of safe air navigation services," FAA officials continue. "The FAA is also committed to working a whole-of-government approach for addressing legal authorities related to the federal government's ability to utilize some technologies to

mitigate UAS threats. Future FAA activities include identification and tracking and other regulatory measures that will go a long way in eliminating a high percentage of errant or unknown UAS operations."

What it does not include, an agency spokesman adds, are any plans for the FAA to use UAVs of its own in a C-UAV capacity.

The evolution of UAVs in the past 25 years can be compared to that of cell phones in the same time. Both have gone from expensive curiosities of only marginal utility to ubiquitous, highly reliable devices with increasingly advanced capabilities. And part of the potential for both good and ill is the ability to merge small commercial UAVs with high-tech smartphones.

"When you talk about technology advancement, you can to see the differences in UAV sizes and abilities just in the commercial world. And industry has responded to that. So as quickly as GoPros and cell phone cameras have advanced, those have migrated into the technology," says Harvey Lai, C-UAV lead at the Army's CERDEC Intelligence & Information Warfare Directorate (I2WD).

This is a growing concern for the military, and, by extension, for anyone else concerned about privacy or security, adds Kevin O'Hanlon, senior engineer in I2WD's Radar Division.

UAV proliferation

"As you start addressing the current threat, it becomes more advanced and capable and you have to address it again. The consumer wants to do more with UAVs, which is a huge driver to put more capability into those you can buy off-the-shelf," O'Hanlon says. "UAVs have proliferated in the past couple of years, largely due to consumer demand. And anyone paying attention can easily see the possibilities of their use as things get cheaper and consumers demand more out of them.

"The Army has to worry about more than just 'is it happening,' but the future potential for any adversary trying to affect us; we have to be ready for whatever potential there may be," O'Hanlon says. "That is our function in the Army, as one of its research and development centers [RDECs], to look at the community and develop long-term strategies for the five- or ten-year path, what's the art of the possible. But it is an ever-changing world, so we do constant updates. It's not an exact science, but something you have to put on paper, start working toward and adjust as needed."

Also looking at both current needs and, to an even greater extent, what may be 10, 20, or even 30 years from now, is the Defense Advanced Research Projects Agency (DARPA), which was created after the Soviet Union launched Sputnik, the world's first satellite, and with it claimed the global lead in both space and technology. DARPA's mission, set out by President Dwight Eisenhower, was not only to ensure the U.S. never again was the victim of technological surprise, but to be the source of all future technology surprises.

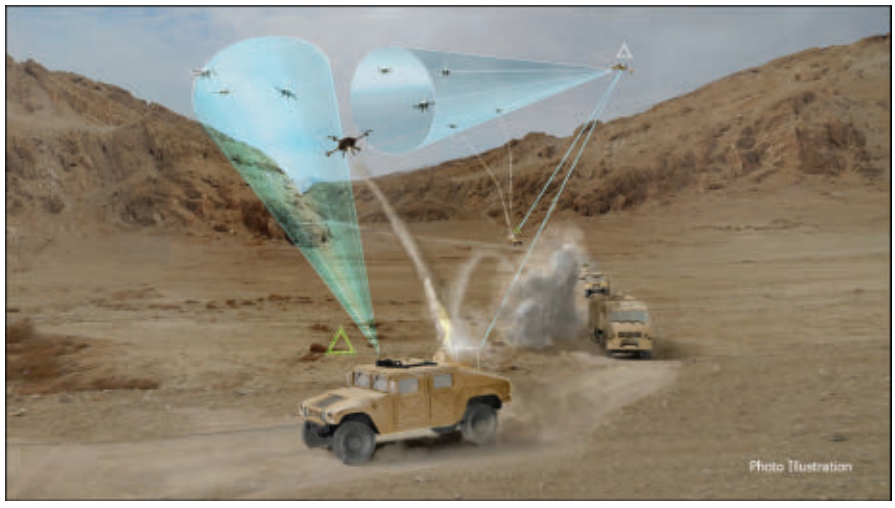
Two ongoing DARPA projects aimed at developing next-generation C-UAV capabilities are the Tactical Technology Office's (TTO's) Mobile Force Protection (MFP) and Aerial Dragnet in the agency's Strategic Technology Office (STO). DARPA outlined the status of and future plans for both in its RDT&E (Research, Development, Testing & Evaluation) Project Justification submission for the U.S. Department of Defense (DOD) 2018 budget estimates.

"The goal of the MFP program is to develop and demonstrate an integrated system capable of defeating a raid of self-guided, small unmanned aircraft attacking a high-value convoy on the move. By focusing on protecting mobile assets, the program

The Battelle DroneDefender system uses RF energy to commandeer encroaching UAVs and lower them safely to the ground. Problems with the U.S. Federal Communications Commission (FCC) has limited its use and deployment.

will emphasize low footprint solutions, in terms of size, weight, and power (SWaP), and manning, which will benefit other counter-UAS missions and result in more affordable systems," the document explains.

"Defending in a variety of operating environments against these sUAS [small UAS] threats and associated concept of operations requires several breakthroughs in affordable technology to 'sense, decide and act' on a compressed timeline while mitigating collateral damage. The program seeks to develop solutions applicable to the defense of mobile ground and naval forces that can also potentially defeat more conventional threats. The solution will be scalable and modular such that it can be deployed in multiple defense applications and does not become obsolete with evolving threat capability," the document continues.



The DARPA Mobile Force Protection (MFP) program seeks to develop an integrated system able to defeat a raid of self-guided small unmanned aircraft attacking a high-value convoy on the move.

Military-civilian crossover

The crossover potential of military C-UAV technologies to civilian applications also is central to MFP, which DARPA is working on not only with all the military services, but also with the DHS Science & Technology Directorate and the U.S. Coast Guard. As part of that, as each open-air demonstration ends, DARPA will offer all interested parties the opportunity to fund extended field evaluations. The agency's stated goal "is to develop the interim versions and the final prototype system to meet the needs of a broad number of potential U.S. government and commercial users."

DARPA recently awarded phase-one agreements to expedite the development of C-sUAV capabilities and get them into the field quickly to three teams, led by Dynetics Inc. in Huntsville, Ala.; Saab Defense and Security USA in East Syracuse, N.Y.; and SRC Inc. in North Syracuse N.Y.

"The three teams we've assembled have innovative ideas for a versatile, layered defense system that could protect convoys on the move from

multiple small unmanned aircraft systems in real time," says Jean-Charles Ledé, the DARPA TTO acting deputy director. "Each team will now work to integrate novel ideas for advanced sensors and neutralization approaches into a common framework, emphasizing safety for civilian bystanders, ease of operation and low size, weight, power, and cost [SWaP-C]. Our goal is a technology demonstration system that could fit onto currently deployed tactical ground vehicles and maritime vessels — getting advanced and upgradeable capabilities quickly to the warfighters who need them."

With respect to Aerial Dragnet, 2018 plans include completing development of initial hardware sensor payloads, evaluating software for non-line-of-sight (NLOS) UAS tracking and classification, and demonstrating and testing system performance over a neighborhood-sized urban area.

"Aerial Dragnet seeks to detect multiple sUAS in complex and urban terrain before they are within LOS of friendly assets," DARPA officials say. "Unlike traditional air targets, sUAS pose a special threat in urban terrain for several reasons: they can fly at low altitudes between buildings; they are small, making them difficult to sense, and they move at slow speeds, making them difficult to differentiate from other movers. Moreover, the development of sUAS is driven by commercial technologies, which make them rapidly adaptable and very easy to use."

The U.S. Navy AN/SEQ-3 Laser Weapon System (LaWS) can destroy enemy unmanned aircraft, as well as other airborne threats. It was installed on USS Ponce for field testing in 2014.

Networked sensors

"Building upon technologies developed in the System of Systems Integration Technology and Experimentation (SoSite) program, Aerial Dragnet will perform surveillance using an architecture consisting of networked sensors mounted on distributed aerial platforms," DARPA officials continue. "The ability to see over and into urban terrain allows an Aerial Dragnet to rapidly detect, track and classify UAS incursions, thus enabling multiple defeat options. This program focuses on the development of payloads, to be hosted on unmanned aerial platforms, comprising signal processing software, sensor hardware, and networking for distributed, autonomous operation."

Scalable to provide cost-effective surveillance from neighborhood to city-sized areas, Aerial Dragnet technologies are expected to move to the Army and U.S. Marine Corps for missions in Europe and Southwest Asia. In addition, with its focus on mounting the system on existing UAVs, it could move quickly to law-enforcement agencies and the U.S. Border Patrol, which is evaluating sUAVs in operational areas.

"We anticipate the sUAS program to be a valuable tool for Border Patrol's highly trained law enforcement personnel in securing our borders and helping identify and intercept illicit activity along U.S. borders," says Carla Provost, acting chief of the U.S. Border Patrol. "These aircraft will enable Border Patrol agents to surveil remote areas not easily accessible by other means, which is critical to our ability to secure the border. They will also be invaluable for humanitarian missions, aiding in locating individuals in need of medical assistance along inhospitable areas of the border."

These aircraft also would be assets in detecting and helping negate UAVs employed by drug cartels and other criminal — and possibly terrorist — organizations along the nation's borders.

Two fixed-wing aircraft and one helicopter are being tested

operationally — AeroVironment's RQ-20 Puma and RQ-11 Raven and Tactical Robotics' InstantEye Quadcopter — all small enough to fit inside a sport utility vehicle (SUV) and be maneuverable and rapidly deployable.

The first of two testing rotations in three Border Patrol sectors — Tucson, Ariz.; Rio Grande Valley, Texas; and Swanton, Vt. — began in September 2017, with the second to begin in January 2018.

After measuring hot- and cold-weather capabilities, Border patrol officials say they expect a final review, including future investment decisions and expansion of the program to other BP Sectors, in late spring 2018. The evaluations are being conducted under an approved Memorandum of Agreement between the FAA and BP that "maximizes risk-avoidance to commercial and general aviation traffic in the National Airspace System."

A second MOA with CBP's Air and Marine Operations is intended to further address "operational risk avoidance in day-to-day operations."

FAA efforts

Over the past two years, the FAA's congressionally mandated UAS Detection Pilot Program conducted a series of evaluations on UAV detection systems at Atlantic City International Airport, JFK International Airport in New York, Denver International Airport, and Dallas-Fort Worth International Airport. The evaluations employed temporary and limited installation of various detection systems under Cooperative Research Development Agreements with several system manufacturers, testing the ability of their sensors and systems to detect approaching UAVs using radar, radio frequency, and electro-optical technologies.

"The effort, in collaboration with industry and federal partners, provided stakeholders with credible, objective and useful information about the performance and capabilities of UAS detection technology, its state of development, and potential areas of risk," says one FAA program official. "This pilot program has concluded and the team

The U.S. Army and Marine Corps can rely on the AN/TWQ-1 surface-to-air missile system, which protects ground units from UAVs, as well as cruise missiles, low-flying fixed-wing aircraft, and helicopters.

is compiling a report based on the technology evaluations conducted."

Meanwhile, DHS, partnered with other federal agencies, is working on common test methodologies and data definitions for C-UAV. As part of that, the FAA's UAS Center of Excellence (CoE) is analyzing data provided by the manufacturers from the airport evaluations. Their results are expected in 2018.

International efforts

Because the threat is international and cuts across all segments of society, the FAA and some of its partners have taken their tests to other nations. For example, they recently observed testing of a prototype C-UAV system at Finland's Helsinki International Airport and technology demonstrations at overseas and domestic DOD bases.

"The FAA has reviewed C-UAS technology testing and assessment findings from DHS, the Department of Energy, DOD, the U.S. Army and Air Force, the Federal Bureau of Prisons, and the FBI," an agency official says. "The FAA also participates in an ongoing whole-of-government effort focusing on issues associated with countering risks posed by UAS, including legal issues, technology developments and domestic use of such technologies.

"To support evaluations, the FAA has employed the services and expertise of the FAA Modernization and Reform Act 2012-mandated UAS Tests Sites, as well as the FAA's UAS CoE. The FAA also has engaged with DHS, DOD, and two Federally Funded Research and Development Corporations to assess the potential cost of deploying such UAS detection technologies at a large metropolitan airport," the FAA official says.

The FAA says its assessments and observations of current UAV detection technologies are limited by the developmental state of most systems being evaluated for civil applications in the United States.

"Until such time as standards are developed and published and more formal test and evaluation is conducted, addressing technological improvements will remain

The SkyWall counter-drone system from OpenWorks Engineering Ltd. in Stocksfield, England, enables operators to capture any suspicious drone and bring it to the ground safely, without raising alarm or causing collateral damage.

difficult. Future solutions will likely comprise multiple sensor systems to provide the most accurate and timely detection and response and will need to evolve to keep pace with UAS technology changes," an agency official says.

"The FAA and its interagency partners will continue to shape potential requirements for UAS detection technology that will assist in keeping the NAS the safest system in the world. Based on the assessments conducted, the FAA has concluded there is no one, simple solution for UAS detection. Future FAA activities, including identification and tracking and other regulatory measures, will be critical to eliminating a high percentage of errant or unknown UAS operations."

No silver bullet

C-UAV development, both military and civilian, continues to pick up speed and urgency, but tests to date have shown there is no "silver bullet" capable of addressing all types of UAVs and their potential payloads, from ISR sensors to eavesdropping smartphones to explosives. Nor is any one lab or agency able to push C-UAV R&D forward with the necessary speed and SWaP-C requirements. CERDEC, for example, is pursuing cooperative investigations into C-UAV detection and mitigation technologies with multiple government agencies, industry and the armed services.

"Research labs in academia are really going after the far-out problem, while most government labs are dealing with the mid-term problem," O'Hanlon says. "There also are working groups stood up to work with our allies, who have different experiences than our own services, so that helps us get to a cooperative solution. It is a system-of-systems approach. Commercial RCMAs [radio-controlled model aircraft] are a challenge to detect, identify, track, and negate. There are shortfalls with every type of sensor, so working as a networked SoS, performance is helped."

CERDEC's Lai says the military's RDECs, in their mid-term solutions search, are "squeezing every bit of capability out of each sensor technology, as they exist today. We are looking at every possibility, working with industry to present quick-reaction capability that is mission-specific, to long-term SoSs, improving sensor technology to address both the here and now and later."

CERDEC officials admit they don't have the answers yet and, given the speed of technology development and breakthroughs, it is unlikely the C-UAV issue will ever be fully resolved before it morphs into an as-yet unknown new threat.

"Part of the work we're doing now is to help work out some of those problems and inform the Big Army on the best or potential solutions so they can decide how to move forward. In general, work with the art of the possible," O'Hanlon adds. "Determining the art of the possible involves confidence in information. Near-term, it's easier to provide a higher confidence look at the threat and what we can do. The further out you go, the more difficult that comes, so you have to make adjustments."

Building readiness through test and measurement

Rapidly advancing technologies and emerging threats are driving increased investment in modern test and measurement tools.

BY **Courtney E. Howard**

Military and aerospace organizations focus on building readiness and filling capability gaps to ensure multi-domain superiority across land, air, sea, space, cyberspace, and the electromagnetic spectrum. Test and measurement equipment plays a key role in achieving these goals, and is the focus of widespread modernization efforts.

Navy personnel perform preflight checks on an F/A-18E Super Hornet aircraft. (Photo: U.S. Navy)

Cybersecurity

Aerospace and defense systems integrators are demanding cybersecurity in all test sets, explains Stephen Sargeant, CEO of Marvin Test Solutions Inc. in Irvine, Calif. "It is best achieved with a combination of software, firmware, and hardware."

Security is paramount in military communications and mission systems, prompting U.S. Navy officials to partner with the BAE Systems Intelligence & Security sector in McLean, Va., on a variety of vital communications and electronics equipment in support of the Naval Warfare Center Aircraft Division (NAWCAD) in Patuxent River Naval Air Station, Md.

The 22-month, $76 million contract calls for BAE Systems to design and maintain communications and electronics platforms, as well as test and certify equipment for NAWCAD's Special Communications Mission Solutions Division. Users include the U.S. Army, Air Force, Joint Special Operations Forces, and other Department of Defense (DOD) and federal government agencies.

"Our customers are always looking for solutions that are designed and built to the most rigorous specifications," says Marvin Test's Sargeant. "Mil-spec is a perfect example of that when the systems will be deployed or employed under adverse conditions." The company is working toward certification to the AS-9100D Quality Management Systems–Requirements for Aviation, Space, and Defense Organizations international standard published by SAE International.

Sargeant recommends selecting products and platforms developed with systems integrators' current

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Sandia tests ensure avionics can withstand shock from stage separation in flight. (Photo: R. Montoya)

and future requirements in mind. "My best advice would be to select solutions that feature commonality and open architecture. Commonality streamlines logistics and makes it possible to reduce the cost of training and relying on fewer supply chains — always a desirable outcome."

"Open-architecture test platforms, such as PXI, offer the flexibility to configure the system you need today, as well as the ability to upgrade and add resources as new requirements emerge," Sargeant continues. PXI is a rugged PC-based platform for measurement and automation systems, developed by National Instruments in Austin, Texas, that combines PCI electrical-bus features with the modular, Eurocard packaging of CompactPCI, specialized synchronization buses, and key software features.

As requirements continue to grow and change, aerospace and defense organizations are increasingly adopting workflow tools offering electronic design automation (EDA), product life cycle management (PLM), requirements traceability, and design verification capabilities from vendors such as Jama Software in Portland, Ore.; Mentor (a Siemens Business) in Wilsonville, Ore.; and others.

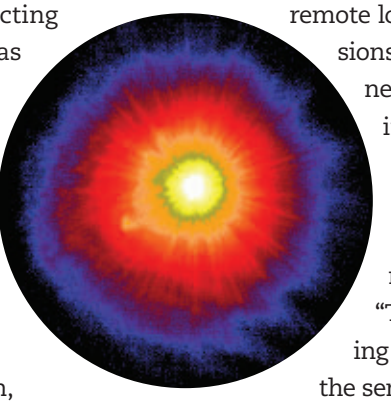
Requirements

The growing complexity and demand for multifunctional, multi-mission capabilities in modern aerospace and defense electronics can result in conflicting system requirements as well as test and measure challenges.

It pushes systems designers toward integrated systems, says David Njuguna, technical marketing manager at Tektronix in Beaverton, Ore. Defense organizations today are deploying "integrated systems for communication, visualization, and threat detection and management, which are enabled by a distributed network of low-cost, low size, weight, and power consumption (SWaP) sensors designed purely for detection, coupled with high-performance analyzers for deeper exploration and decision-making," he says. Systems supporting these defense trends require broad frequency range, wide instantaneous bandwidth, and real-time streaming and processing capabilities.

"Although the systems supporting these defense trends have some common requirements, including real-time streaming and processing capabilities, they also have some diverging requirements," Njuguna says. The distributed networks require low SWaP and low cost while still maintaining signal fidelity, and the performance receiver/analyzer requires higher resolution, wider instantaneous bandwidth, and deeper capture memory, including more powerful real-time processing capabilities.

Tektronix USB real-time spectrum analyzers (RSAs), such as the RSA306B or RSA500, are deployed in remote locations as an emissions-characterization network to identify interferers, rogue emissions, and adversarial threat or communication signals, Njuguna says. "The decision-making occurs either at the sensor itself, or using the Tektronix RSA5000 series or RSA7100 as the high-performance analyzer to capture and perform deeper analysis on signals of interest initially discovered by the distributed network of USB RSAs."



THAAD weapon system intercepts target. (Photo: DOD)

USB RSAs also are being deployed on ships and aircraft as the front end for legacy receivers evaluating the electromagnetic environment and to help make decisions on

radiation hazards, emission control, and other electromagnetic interference (EMI) protection for sensitive equipment, Njuguna adds.

"For the distributed networks, while intended to be low-cost and low-SWaP, you must still consider the necessary signal fidelity and the ability to stream data when choosing your sensor," Njuguna says. "For the higher-performance analyzer, consider the ability to first detect the signal of interest in a congested environment and also the need for streaming while performing deeper analysis."

Weapon systems

Aerospace and defense organizations are doing more with less, and require the same of their electronics systems and their test and measurement tools. Scalability and flexibility are key attributes of a modern test system as users look to apply one solution for as long as a decade to test vehicles, ships, and aircraft.

Ensuring the readiness of weapons systems and missile defenses is a top concern today. Instruments from Marvin Test Systems, for example, are designed to support test requirements for maintenance and sustainment of missile systems, helicopters, fixed-wing aircraft, and unmanned aerial vehicles (UAVs). The company supplies weapon system test solutions tailored to maintenance levels from production, to the flight line, to the depot.

Legacy test and measurement equipment suffers from major reliability and obsolescence issues, as well as design limitations that curtail their ability to support future requirements. These are among the reasons that defense organizations worldwide are replacing decades-old test and measurement equipment in favor of more modern, future-proof designs.

Kontron's Cab-n-Connect A100 is part of Lufthansa Systems' testbed on FlyingLab flights.

Officials of the Naval Air Warfare Center Aircraft Division in Lakehurst, N.J., sought to replace the aging A/E37T-35A common rack and launcher test set (CRALTS) used to assess missile and weapons

launchers on the F/A-18 jet fighter bomber and other combat aircraft.

They found their solution at Behlman Electronics in Hauppauge, N.Y., awarding a $21.7 million contract for as many as 180 Common Aircraft Armament Test Sets (CAATS) and 100 Pure Air Generator System Adapter Sets (PAGS PAS). The new weapons-launcher test and measurement equipment will help test and troubleshoot U.S. Navy, Marine Corps, and international military bomb racks, missile launchers, pylons and emerging weapons carriage devices across most aircraft weapons systems at the intermediate maintenance level.

Personnel in the Navy, Marine Corps, and militaries of Spain, Italy, Finland, and Kuwait will use the CAATS system to test rack and launcher weapons interfaces of the aircraft to ensure proper system functionality and safety prior to loading ordnance. The PAS interfaces with the CAATS to test LAU-7 and LAU-127 high-pressure pure air generator (HiPPAG) weapons launchers, and provides pressure test capability to evaluate emerging pneumatic pressure-release launchers, such as the Joint Miniature Munitions Bomb Rack Unit.

The LAU-7 air-to-air missile launcher carries and deploys the AIM-9 heat-seeking missile and instrumentation pods on Navy and Marine Corps F/A-18 fighter-bombers. The LAU-127 missile rail launcher enables the F/A-18 to carry and launch the radar-guided AIM-120 Advanced Medium-Range Air-to-Air Missile and AIM-9X advanced heat-seeking missile, and provides the electrical, mechanical, and data-transfer interface between missiles and aircraft cockpit controls and displays.

OneWeb Satellites begins end-to-end validation, testing, and integration of its first satellites.

Missile defense

The U.S. Missile Defense Agency (MDA), the U.S. Army, and industry joined forces at the end of July 2017 to test a critical missile defense capability, the Terminal High Altitude Area Defense (THAAD) system, built by an industry team led by Lockheed Martin in Bethesda, Md.

The THAAD system at Pacific Spaceport Complex Alaska in Kodiak, Alaska, detected, tracked, and intercepted an intermediate-range ballistic missile (IRBM) target, achieving its first IRBM intercept.

During the test, a U.S. Air Force C-17 Globemaster III military transport aircraft air-launched a ballistic missile target over the Pacific Ocean north of Hawaii. The THAAD radar detected, acquired, and tracked the target, after which the THAAD system launched an interceptor that destroyed the target's reentry vehicle with the force of a direct collision.

This test marked the 14th successful intercept in 14 attempts for the THAAD system since 2005. The Ballistic Missile Defense Operational Test Agency, Department of Defense Operational Test and Evaluation, Army Test and Evaluation Command, U.S. Army, Joint Forces Component Command for Integrated Missile Defense, U.S. Air Force, U.S. Coast Guard, and Pacific Spaceport Complex Alaska (PSCA) provided support. MDA officials anticipate deploying 50 THAAD weapon systems globally by September 2018.

The THAAD system is rapidly deployable, mobile, and interoperable with other Ballistic Missile Defense System (BMDS) elements, including Patriot/PAC-3, Aegis, forward-based

Marvin Test Systems' GENASYS is used to test board- and box-level satellite subassemblies.

The Terminal High Altitude Area Defense (THAAD) system is undergoing testing.

sensors, and the Command, Control, Battle Manage-ment and Communications system. It employs RS255 2U and RS378 3U rugged servers from Crystal Group in Hiawatha, Iowa, to better withstand transport across various terrains, use in harsh environments, and extreme shock and vibration.

Shock and space

Engineers are improving current methods of testing critical aerospace components and systems, such as shock tests of avionics and space launch system or rocket parts.

Engineers at Sandia National Laboratories in Albuquerque, New Mexico, have demonstrated a way to test rocket parts to ensure that rocket avionics can withstand the shock from stage separation during flight. Designed to be more environmentally friendly than current techniques, the Alternative Pyroshock Test uses a nitrogen-powered gas gun to shoot a 100-pound steel projectile into a steel resonant beam, which transfers energy through a resonant cone attached to the part being tested. The resulting energy transfer mimics the conditions of stage separation in space. The first test of this type using flight hardware was completed last spring.

Previous pyroshock tests to ensure aerospace parts were ready for the rigors of flight used explosives encased in lead to provide the impacts to parts needed for such experiments, Sandia Mechanical Engineer Mark Pilcher explains. The lead and

explosives were environmental hazards, making cleanup costly and time-consuming.

"We recognized early in the program that we need to seek out alternative test methods in order to reduce our hazardous work exposure, minimize environmental waste, and develop a controlled and repeatable test capability," Pilcher says.

"The same concept can be used for a variety of defense and space applications," Sandia Mechanical Engineer Bo Song says. "This provides a new path for pyroshock testing, but very clean and more controllable and will save a lot of costs."

Satellites

Testing components and systems to ensure they will withstand the rigors of space, include shock and vibration during launch and potentially decades in orbit amid damaging radiation. This is no small feat – particularly while keeping pace with the fast-moving satellite sector.

"The satellite communications industry is undergoing rapid changes and growth," says Darren McCarthy, aerospace & defense technical marketing manager at test house Rohde & Schwarz America in Beaverton, Ore. "The evolution of satellite technology and support for NewSpace innovations are driven by the numerous commercial ventures in space and near space. It is forcing the satellite communications industry to break from traditional test and measurement methods and take a new look at commercial test practices to meet demand."

Technology transfer trends extend to test and measurement. "A forcing function in the satellite communications industry in the development of waveform technology and antenna beam steering is very synergistic to developments necessary to support commercial 5G technology," McCarthy says. In supporting NewSpace applications for fast data communications, consider the radio-frequency (RF) performance — phase noise, bandwidth, level flatness, and dynamic range as measured by the error-vector-magnitude (EVM) performance — and ease of use of test equipment, he advises.

The Tektronix RSA7100A wideband signal analyzer provides real-time spectrum analysis.

Speed of test and reduced uncertainty are influencing test and measurement equipment selection. "Speed of test has always been a big driver in satellite communications and, with the increased volume and focus on reduced cost of test, this is still a focus of payload test customers," McCarthy explains.

"Measuring spurious emissions, especially on the launch vehicle, is very time consuming using traditional spectrum analyzers. Emission limits can be as low as -140 decibel-milliwatts (dBm) across many gigahertz of bandwidth to avoid sensitive receiver bands. This is not only for the test and evaluation phase of the payload, but also during EMI qualification," McCarthy says. "Due to the MIL-STD 461G explicit introduction of time-domain scan test methodology as an accepted technique, in one space vehicle test case, this enabled several weeks of testing to be condensed into a few hours."

COMPANY LIST

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Navy eyes high-speed SATCOM for P-8A Poseidon surveillance aircraft

BY **John Keller**

PATUXENT RIVER NAS, Md. — U.S. Navy avionics experts are moving forward with a project to upgrade the Navy fleet of P-8A Poseidon maritime patrol and anti-submarine warfare (ASW) aircraft with high-speed satellite communications (SATCOM) capability.

Officials of the Naval Air Systems Command at Patuxent River Naval Air Station, Md., announced a $16.3 million order to the Boeing Co. in Seattle to develop an airworthy design to integrate a Wideband Global SATCOM system radome and supporting infrastructure on the P-8A aircraft.

The Wideband Global SATCOM system, otherwise known as WGS, is a high-capacity SATCOM link for the U.S. and Australian militaries that will augment and eventually replace Defense Satellite Communications System (DSCS) and Global Broadcast Service (GBS) satellites.

One WGS spacecraft has as much bandwidth as the entire existing DSCS constellation, experts say. WGS will offer 4.875 GHz of instantaneous switchable bandwidth; thus, each WGS can supply more than 10 times the capacity of a DSCS III Service Life Enhancement Program (SLEP) satellite.

WGS-1, launched in 2007, has 2.4 gigabit-per-second wideband capacity, which provides greater capability and bandwidth than all the DSCS satellites combined.

Users include the Australian and Canadian militaries, as well as and U.S. Army ground mobile terminals, U.S. Navy ships and submarines, national command authorities for the nuclear forces, and various national security and allied national forces. Previous to the WGS, the U.S. military relied on DSCS and GPS satellites for wideband SATCOM.

Future Navy P-8A Poseidon surveillance aircraft may be fitted with high-speed satellite communications to provide Internet in the sky capability.

The Boeing Defense, Space & Security segment in Seattle will design a WGS SATCOM system radome and supporting infrastructure from a preliminary design review level of maturity to a critical design review level of maturity aboard Navy P-8A aircraft.

The P-8 is a militarized version of the Boeing 737 single-aisle jetliner. It is designed for high- and low-altitude maritime patrol and surveillance.

The P-8A is designed for anti-surface warfare and shipping interdiction. It can carry torpedoes, depth charges, Harpoon anti-ship missiles, and other weapons. It also can drop and monitor sonobuoys, and operate together with the Northrop Grumman MQ-4C Triton Broad Area Maritime Surveillance unmanned aerial vehicle (UAV).

The P-8A also has a growing and sophisticated suite for electronic surveillance and signals intelligence (SIGINT) systems which enable the aircraft to widen its role beyond maritime patrol and ASW to strategic reconnaissance duties.

On this order Boeing will do the work in Seattle, and should be finished by October 2018. ←

FOR MORE INFORMATION visit **Boeing Defense, Space & Security** online at *www.boeing.com/company/about-bds*, and **Naval Air Systems Command** at *www.navair.navy.mil*.

Adversaries creeping up on stealth aircraft

By 2022, about one-fourth of U.S. Air Force combat aircraft will feature stealth technology. And as older platforms retire, and newer ones such as the F-35 Joint Strike Fighter and the B-21 Bomber replace them, that percentage will only grow. That fact has not been lost on potential rivals, who have watched the Air Force use the game-changing technology with great effect since its success over the skies of Baghdad during the first Gulf War in 1991. But what about the long term? Will there be an equally game-changing defensive technology that renders this advantage obsolete? That's one of the questions retired Air Force officers Maj. Gen. Mark Barrett and Col. Mace Carpenter sought to answer in a report, "Survivability in the Digital Age: The Imperative for Stealth," produced by the Mitchell Institute for Aerospace Studies. "Over the long run, the U.S. will engage opponents who field increasing numbers of powerful digital multi-band radars," the authors wrote. That is particularly troubling when ground-based systems alert surface-to-air missile (SAM) batteries about approaching aircraft. The authors highlight several other methods adversaries can pursue that could help them detect stealthy aircraft. ←

Boeing and Lockheed Martin build extra-large UUVs for long-endurance missions

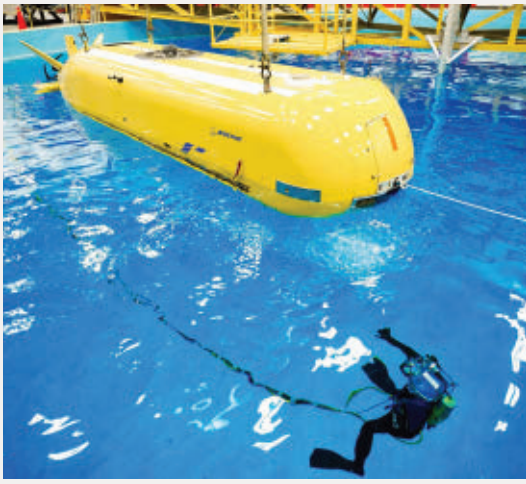
BY **John Keller**

WASHINGTON — Undersea warfare experts at two of the nation's largest defense contractors are designing prototype extra-large unmanned underwater vehicles (UUVs) with the potential to undertake long-endurance missions to deploy sensors or other UUVs.

Officials of the U.S. Naval Sea Systems Command in Washington have awarded contracts to the Lockheed Martin Rotary and Mission Systems segment in Riviera Beach, Fla., and the Boeing Defense, Space & Security segment in Huntington Beach, Calif., to design the Orca Extra Large Unmanned Undersea Vehicle (XLUUV) system.

Extra-large UUVs typically are autonomous mini-submarines that measure about seven feet in diameter — sometimes larger. They are designed for launch from shore or from large military ships with well decks, or from large civil vessels with moon pools. The Navy is not releasing the value of the XLUUV contracts to Boeing and Lockheed Martin.

XLUUVs, among the largest unmanned submersibles ever conceived, will be for long-endurance surveillance missions or undersea cargo vessels to deliver other sensor payloads and other UUVs. These large unmanned undersea vehicles eventually could be used as motherships to deploy and recover smaller surveillance UUVs on reconnaissance, surveillance, or special warfare missions in the open ocean or along coastlines and inside harbors.



Boeing and Lockheed Martin are designing prototype extra-large unmanned underwater vehicles (UUVs) with the potential to undertake long-endurance missions to deploy sensors or other unmanned systems.

The Navy and U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., have involved Lockheed Martin and Boeing on a variety of large UUV projects, such as the Large-Displacement Unmanned Underwater Vehicle (LDUUV) project. An LDUUV typically is described as an autonomous submarine no larger than 80 inches in diameter. Future XLUUVs likely will be larger. Experience with the LDUUV will help inform concepts for using XLUUV.

DARPA issued a solicitation last spring for the Hunter program to develop a payload-delivery system from an extra-large UUV. The Hunter program, however, involves only the payload delivery system and not the extra-large UUV itself. Hunter payloads could involve persistent-surveillance sensors, weapons, or other

unmanned underwater vehicles and unmanned aerial vehicles (UAVs).

The XLUUV project is moving enabling technologies forward that were developed originally in other projects, such as the DARPA Hydra program to develop an unmanned submersible large enough to transport and deploy UAVs and UUVs stealthily in enemy territory.

Boeing has developed the Echo Voyager, a 51-foot large UUV that can reach depths of 11,000 feet and operate independently for months underwater. Boeing unveiled the Echo Voyager in early 2016 and began sea trials of the unmanned undersea craft that summer.

Boeing and Lockheed Martin were involved in a DARPA project two years ago called Blue Wolf, which focused on revolutionary underwater propulsion and drag-reduction technologies to enable manned and unmanned military undersea vehicles to move through the water faster and more energy-efficiently than ever before. The Blue Wolf program demonstrated integrated underwater vehicle prototypes able to operate at speed and range combinations previously unachievable in fixed-size platforms, while retaining traditional volume and weight fractions for payloads and electronics. Blue Wolf involved dynamic lift from winglets, body shaping, coatings, and novel drag reduction technologies applicable over various range and speed combinations.

Lockheed Martin has been involved in a U.S. Special Operations Command (SOCOM) Dry Combat Submersible (DCS) program to design an affordable mini-submarine able to transport Special Operations combat swimmers, such as Navy SEALs, covertly while minimizing swim time to keep the divers from becoming too exhausted to carry out missions. Lockheed Martin also has experience with the Navy's Remote Multi-Mission Vehicles (RMMV) UUVs for use in countermine warfare aboard the U.S. Navy's Littoral Combat Ship.

Boeing will do the work on the Orca XLUUV program in Huntington Beach, Calif.; Groton, Conn.; Centreville, Va.; Camden, N.J.; and Newport News, Va. Lockheed Martin will do its work in Riviera Beach, Fla.; Syracuse and Owego, N.Y.; Manassas, Va.; Marion, Mass.; and Morristown, Pa.

HD thermal camera for military imaging introduced by Sierra Olympic

Sierra-Olympic Technologies Inc. in Hood River, Ore., is introducing the infrared Vayu HD uncooled thermal camera for military imaging, airborne reconnaissance, security, border protection, and wide-area surveillance. The thermal imager features long-wave infrared (LWIR) spectral response from 8 to 14 microns, and offers 1920-by-1200-pixel, high-definition (HD) resolution with 1080-pixel output. The rugged Vayu HD provides image resolution with a vanadium oxide microbolometer (VOx) sensor with a capacity of more than 2.3 million pixels on a 12-micron pixel pitch, in a commercially designed, IP67-environmentally rated, stand-alone camera. Other features include an athermalized 24-millimeter F1.1 custom-designed optic, 30 Hz frame rate, and three video formats: HD-SDI, h.264 IP-Video, or 16-bit Camera Link output.

Rugged fiber-optic cable for aircraft networking and displays introduced by OFS

OFS Fitel LLC in Avon, Conn., is introducing the FlightLinx PLUS rugged fiber-optic cable for inflight entertainment, Internet access, and networking and display systems on commercial aircraft. The cable is for pull-proof termination during harsh aircraft installations because it helps prevent kinking and fiber breakage during and after deployment. FlightLinx PLUS fiber-optic cable is a 1.8-millimeter ruggedized single-jacket cable that meets ARINC 802 without a double jacket.

Clear Align boosts electro-optics expertise with General Dynamics facility acquisition

BY **John Keller**

EAGLEVILLE, Pa. — Aerospace and defense electro-optics specialist Clear Align LLC in Eagleville, Pa., is boosting the company's expertise in military surveillance, reconnaissance, and fire control with its acquisition of the Nashua, N.H.-based pan-tilt systems lens design and optical component facilities of General Dynamics Mission Systems.

The acquisition from General Dynamics brings to Clear Align additional expertise in pan-tilt surveillance systems, infrared cameras, and optics for satellite and space telescopes, maritime targeting, and ground and airborne surveillance, says Clear Align CEO Angelique X. Irvin.

Qualified products, intellectual property, and sales backlog that Clear Align is acquiring from General Dynamics are for defense and homeland security applications, naval surveillance, remote targeting, and unmanned vehicles applications, Irvin said at the Association of the U.S. Army show in Washington.

Financial details of the acquisition have not been released. Clear Align specializes in electro-optic systems and optical components to defense, aerospace, and medical applications. The company builds products for the ultraviolet (UV), visible light, as well as near-, short-wave, medium-wave, and long-wave infrared portions of the electromagnetic spectrum.

Clear Align is making the jump from electro-optical component manufacturer to subsystems designer with its acquisition of a Nashua, N.H., facility of General Dynamics Mission Systems.

Clear Align's laser and sensing expertise includes optical integration for remote sensing and targeting, and the company provides build-to-print, and custom design, prototype, manufacturing, and systems integration services.

"This is a large operation being integrated into a small organization," Irvin says, pointing out that this portion of General Dynamics Mission Systems is significantly larger than Clear Align was before the acquisition. The deal indicates an imaging industry consolidation of two key competitors and ended in one of the largest component suppliers in the United States, Irvin says.

With the technology and expertise acquired from General Dynamics, Clear Align can provide target detection, recognition, and identification capabilities in pan-tilt imaging

systems, including the ability to put 48 pixels on a target at 7.5 miles, and four pixels on a target at 16 miles.

Irvin calls the Nashua, N.H., facility that Clear Align is acquiring from General Dynamics one of the largest optical-fabrication facilities in the United States. It includes more than 50 large optical fabrication machines that make optics, and provide optics diamond turning, polishing, grinding, coating, integration, and environmental testing for imaging, with a specialty in high-definition (HD) imaging.

With this acquisition, Clear Align enhances its position as an imaging system supplier for unmanned aerial vehicles (UAVs), and enters the market for military land vehicle-mounted fire-control systems, Irvin says.

The acquisition consolidates Clear Align's existing facilities in Hudson, N.H., into the new facility.

FOR MORE INFORMATION visit **Clear Align** online at *www.clearalign.com*, or **General Dynamics Mission Systems** at *https://gdmissionsystems.com*.

Army kicks off 10-year program to build target designation laser range finder

BY **John Keller**

ABERDEEN PROVING GROUND, Md. — U.S. Army navigation and targeting experts are ready to kick off a 10-year program to build an electro-optical, all-weather, day-and-night target designation and laser range finder system to help forward observers guide smart munitions to their targets.

Officials of the Army Contracting Command at Aberdeen Proving Ground, Md., issued a presolicitation (W91CRB-18-R-0001) in October for the Lightweight Laser Designator Rangefinder (LLDR) 3 program. A formal solicitation is expected sometime in December.

The LLDR 3 will be a man-portable, crew-served, ground-based targeting device for precision long-range target acquisition, target location, laser designation, and laser spot imaging with an all-weather day and night precision targeting capability.

It will be a modular, tripod-mounted target observation, location, and designation system for forward observers as part of a fire support team, scouts, and others to execute "call-for-fire" missions, including those for precision-guided, laser-guided, and all other munitions.

The LLDR 3 also will help guide laser seeker-equipped aircraft to high-value targets. When connected to a forward-entry system the LLDR 3 will forward information to higher authorities.

The system will have three separate modules: a targeting locator module; long-range thermal imaging module; and a laser designator module.

The program will involve initial design and integration of 15 units, tested and qualified for production, no later than two years after contract award, followed by initial production and full-rate production of the LLDR 3. The program will last for 120 months, or 10 years.

As with many military technology programs, LLDR 3 requires a diminishing manufacturing sources and material shortages (DMSMS) program using a risk-based approach for electronics, commercial off-the-shelf (COTS) items, firmware, operating systems, and software. The winning contractor will take corrective actions to mitigate obsolescence.

The U.S. Army is ready to issue a solicitation for a new all-weather, day-and-night target designation and laser range finder to help forward observers guide smart munitions to their targets.

Contact the Army's Karen Gibson at *karen.gibson2.civ@mail.mil* or 410-278-5405 with questions or concerns.

MORE INFORMATION IS online at *http://www.fbodaily.com/archive/2017/10-October/19-Oct-2017/FBO-04715226.htm*.

PRODUCT applications

RF AND MICROWAVE

Northrop Grumman to provide components for radar and electronic warfare

Military aviation experts at Northrop Grumman Corp. are providing new embedded computing and RF and microwave components to increase production capability of the U.S. Navy AN/APR-39 family of airborne electronic warfare radar warning receiver avionics.

Officials of the Naval Air Systems Command at Patuxent River Naval Air Station, Md., announced a $124.7 million contract to the Northrop Grumman Mission Systems segment in Rolling Meadows, Ill., for a variety of electronic components for the AN/APR-39D(V)2 — the latest upgrade to the AN/APR-39 radar warning receiver.

The AN/APR-39 family of radar warning receivers is for a variety of Navy fixed-wing aircraft, helicopters, and naval vessels. It detects radar threats to aircraft, such as radar ground sites and particularly radar-guided missiles.

Navy avionics officials are ordering these new electronic components to increase production capacity to meet necessary fielding requirements for the AN/APR-39D(V)2 for the U.S. Navy, Army, and the governments of Japan, Austria, and Canada.

For the AN/APR-39 radar warning receiver, Northrop Grumman will provide 127 D(V)2 processors; 462 D(V)2 antenna detectors; 290 D(V)2 radar receivers; 121 D(V)2 low band arrays; 168 D(V)2 battery handle assemblies; 20 D(V)2 circuit card assemblies; 40 C(V)2 processors; 63 C(V)2 antenna detectors; 131 C(V)2 radar receivers; 19 C(V)2 upgrade kits; and two test stations.

In mid-2012, the Navy asked Northrop Grumman to upgrade the Navy's AN/APR-39 family of radar warning receivers with new digital signal processing (DSP) capability based on 6U-form-factor circuit cards.

The APR-39 provides 360-degree coverage around the aircraft. When the system detects radar threats, it alerts the aircraft crew to each threat with a graphic symbol on the cockpit display. The system provides the pilot and air crew with information on threat types, bearing, and the severity of the threat.

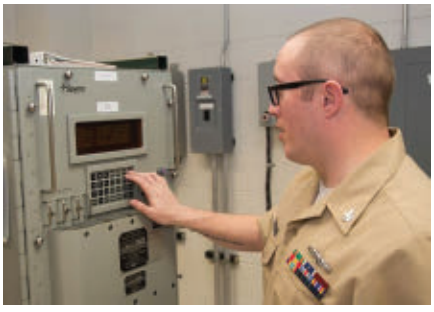
FOR MORE INFORMATION visit **Northrop Grumman Electronic Systems** online at *www.northropgrumman.com*.

NAVIGATION AND GUIDANCE

Sperry Marine to build AN/WSN-7 shipboard navigation systems

U.S. Navy shipboard navigation and guidance specialists are squeezing all the life they can out of the AN/WSN-7 ring laser gyro navigation system for Navy surface vessels and submarines.

Officials of the Naval Sea Systems Command in Washington announced



an $11 million order to the Northrop Grumman Sperry Marine segment in Charlottesville, Va., to build more of the company's AN/WSN-7 navigation system. The self-contained, ring laser gyro inertial navigation system senses ship motions, computes the ship's precise position, velocity, attitude, heading, and rates in digital and analog formats, and forwards the data to other vital ship systems.

Sperry Marine is developing the Inertial Navigation Systems Replacement (INS-R) Inertial Sensor Module (ISM), the AN/WSN-12, to replace the WSN-7. Sperry Marine will do the work in Charlottesville, Va., and should be finished by April 2019.

FOR MORE INFORMATION visit **Northrop Grumman Sperry Marine** online at *www.northropgrumman.com*.

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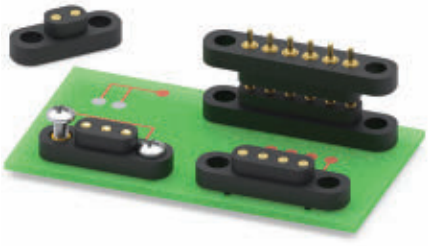
new PRODUCTS

To submit new products for consideration, contact John Keller at jkeller@pennwell.com.

CONNECTORS

Target connector for rugged applications introduced by Mill-Max

Mill-Max Manufacturing Corp. Inc. in Oyster Bay, N.Y., is introducing a target connector on 4-millimeter pitch for rugged applications with a flanged base and hardware options for secure mounting. This target



connector series is the mating half to the recently released 858 series ruggedized spring-loaded connector. Offered in two to six positions in through-hole, SMT, and SMT with alignment pin versions, this target connector series features a high-temperature molded Nylon 46 housing compatible with RoHS soldering processes.

Mounting tabs integrated into the housing provide a means for secure attachment to the circuit board or product assembly. The tab holes may be specified with threaded inserts or left empty for other hardware requirements. The flanged base provides stability for the connector. The pins are plated with 10 micro inches hard gold over nickel for durability and excellent conductivity.

FOR MORE INFORMATION visit Mill-Max online at *www.mill-max.com/PR680*.

RF AND MICROWAVE

RF and microwave heat sinks and cooling fans introduced by Pasternack

RF and microwave components specialist Pasternack Enterprises Inc. in Irvine, Calif., is introducing RF and microwave power amplifier accessories that include heat sinks, heat sinks with cooling fans, power control cable assemblies, and other thermal management components for test and system-level applications. Pasternack offers eight different heat sink models, some of which are designated for general-purpose usage and others are configured for select power amplifier models. These heat sinks feature finned extrusion profiles with large base-

plate mounting surfaces and AC or DC power supply options for models that support integrated cooling fans. Heat sinks are devices that enhance heat dissipation from a hot surface and are ideal for thermal management of power amplifiers in test and measurement applications.

FOR MORE INFORMATION visit Pasternack online at *www.pasternack.com*.

POWER SUPPLIES

PMBus communications interface for modular power supplies introduced by TDK

TDK-Lambda Americas Inc. in San Diego is introducing a Power Management Bus (PMBus) communications interface option card for the company's 700- to 1500-watt QM series of modular power supplies. PMBus is an open-standard digital power management protocol that enables power devices to communicate with each other. The QM power supplies, available with as many as 16 outputs, have full medical means of patient protection (MOPP) isolation and low acoustic noise. The addition of PMBus enables the user or system to turn the QM power supplies on and off remotely (inhibit or enable mode), read back their incoming air temperatures, total operating hours, fan speed, fan status, and manufacturing details. Users can connect as many as eight QM power supplies to one controller. Included on the option card is a 5-volt, 2-amp standby output (always on) and a Fan Fail signal output.

FOR MORE INFORMATION visit TDK-Lambda Americas online at *www.us.tdk-lambda.com/lp/products/qm-series.htm*.

BATTLEFIELD NETWORKING

Rugged device to protect battlefield networks introduced by Orolia

Orolia Spectracom Corp. in Rochester, N.Y., is introducing VersaPNT for virtually failsafe battlefield navigation and for protecting critical networks with assured positioning, navigation, and timing (PNT) technology — even in GPS-denied environments. Spectator, an Orolia Group business, is providing VersaPNT as a ground, air, or sea vehicle-mounted solution for military environments. It has a ruggedized, compact, low-power, and lightweight form factor. Today,

military vehicles are portable networks, providing connections with U.S. headquarters, regional command posts, and individual soldiers, company officials say. Remote areas are challenging environments for military networks, and enemy forces are jamming, spoofing, and disrupting operations. VersaPNT provides essential command and control, navigation, communications, and electronic intelligence support for U.S. and allied military, homeland security, first responder, civilian agency, special operations, and intelligence missions.

FOR MORE INFORMATION visit Orolia spectrums online at *https://spectracom.com*.

RUGGED SERVERS

Rack-mount server for battlefield sensor fusion introduced by Crystal Group

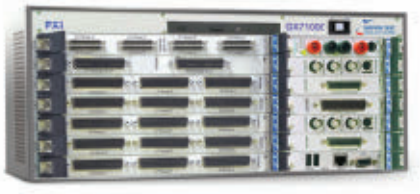
Crystal Group Inc. in Hiawatha, Iowa, is introducing the Fully Optimized Rugged Computer Equipment (FORCE) rugged computer server line for military battlefield applications that involve sensor fusion, machine learning, artificial intelligence, autonomy, electronic warfare, and similar compute-intensive tasks. The FORCE RS1104, RS2608, and RS3712 rugged rackmount servers marry Intel Xeon scalable processors with high-speed networking, enhanced I/O, platform security, and thermal management in a modular, customizable high-performance computing (HPC) system. The Crystal Group FORCE RS1104L22 is an Intel Xeon Skylake powered server able to dissipate 280 watts of CPU power with liquid cooling. Crystal Group FORCE Rugged Servers come with single or dual Intel Xeon scalable processors each supporting as many as 24 cores and 48 PCI Express lanes. The Intel Advanced Vector Extensions 512 (AVX-512) vector processing accelerates repetitive tasks. The Platform Controller Hub offers 10 Gigabit Ethernet ports for high-speed communication, as many as 14 SATA 3 ports for expanded storage capacity, and QuickAssist Technology (QAT) for enhanced security, authentication, and compression.

FOR MORE INFORMATION visit Crystal Group at *www.crystalrugged.com*.

TEST AND MEASUREMENT

PXI Express chassis for modular test in avionics introduced by Marvin

Marvin Test Solutions Inc. in Irvine, Calif., is introducing three PXI Express chassis for use as modular, scalable test and measurement systems for avionics and other aerospace and defense electronics. The chassis offer a combination of PXI Express, hybrid slots, and PXI-1 to enable users to configure resources for general-purpose and high-bandwidth test applications. All three chassis support integral smart functions, including system power supply, slot temperature, and fan speed control and monitoring, as well as PXI trigger mapping. “The flexibility and open



architecture of PXI and PXI Express make it possible to configure the right system for today’s requirements, and to upgrade and add resources when new requirements emerge,” says Marvin Test CEO Steve Sargeant. The GX7100e series are 14-slot PXI Express 3U and 6U combination smart chassis with a 4x4 Gen2 backplane, and support external and embedded controller configurations. The combination of 3U and 6U slots provides versatility and flexibility in a compact footprint.

FOR MORE INFORMATION visit Marvin Test Solutions online at *www.marvintest.com*.

new PRODUCTS

CHASSIS AND ENCLOSURES

ATR for conduction-cooled 3U or 6U OpenVPX development introduced by Pixus

Pixus Technologies in Waterloo, Ontario, is introducing the ATRD058HEX-3U low-cost demonstration and development air transport rack (ATR) for conduction-cooled 3U or 6U OpenVPX embedded computing systems. The enclosure includes rear fans for supplemental cooling of high-power cards, and features a 6-slot 3U OpenVPX backplane to 8-gigabit-per-second PCI Express Gen3 speeds. The enclosure includes a VITA 62 power supply slot. Other backplane slot sizes and various VITA 65 profiles are available. The development unit is slightly wider than a short half ATR. The conduction-cooled ATR has heat-exchange features that include internal long fins to expel heat conductively. To provide more heat dissipation, dual rear fans pull air over the fins from a slotted outer shell. The chassis is sealed, but provides enhanced cooling. The enclosure cools a minimum of 375 watts in the 3U OpenVPX ATR format with options for a 6U version. Implementations providing as much as 600 watts can be customized with additional thermal management provisions.

FOR MORE INFORMATION visit Pixus Technologies online at *www.pixustechnologies.com*.

ADVERTISERS INDEX

Military & Aerospace Electronics

GROUP PUBLISHER **Alan Bergstein**
603 891-9447/alanb@pennwell.com

EDITOR-IN-CHIEF **John Keller**
603 891-9117/jkeller@pennwell.com

EXECUTIVE EDITOR **Courtney E. Howard**
509 413-1522/courtney@pennwell.com

CONTRIBUTING EDITOR WESTERN BUREAU **J. R. Wilson**
702 434-3903/jrwilson@pennwell.com

ART DIRECTOR **Meg Fuschetti**

PRODUCTION MANAGER **Sheila Ward**

SENIOR ILLUSTRATOR **Chris Hipp**

AUDIENCE DEVELOPMENT MANAGER **Debbie Bouley**
603 891-9372/debbieb@pennwell.com

AD SERVICES MANAGER **Glenda Van Duyne**
918 831-9473/glendav@pennwell.com

MARKETING MANAGER **Gillian Hinkle**
603 891-9126/gillianh@pennwell.com

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EDITORIAL OFFICES
PennWell Corporation,
Military & Aerospace Electronics
61 Spit Brook Road, Suite 401, Nashua, NH 03060
603 891-0123 • FAX 603 891-0514 • www.milaero.com

SALES OFFICES
EASTERN US & EASTERN CANADA & UK
Bob Collopy, Sales Manager
603 891-9398/Cell 603 233-7698
FAX 603 686-7580/bobc@pennwell.com

WESTERN CANADA & WEST OF MISSISSIPPI
Jay Mendelson, Sales Manager
4957 Chiles Drive, San Jose, CA 95136
408 221-2828/jaym@pennwell.com

REPRINTS **Jessica Stremmel**
717 505-9701 x2205/Jessica.stremmel@theygsgroup.com

DIRECTOR LIST RENTAL **Kelli Berry**
918 831-9782/kellib@pennwell.com

For assistance with marketing strategy or ad creation, please contact PennWell Marketing Solutions
Paul Andrews, Vice President
240 595-2352/pandrews@pennwell.com

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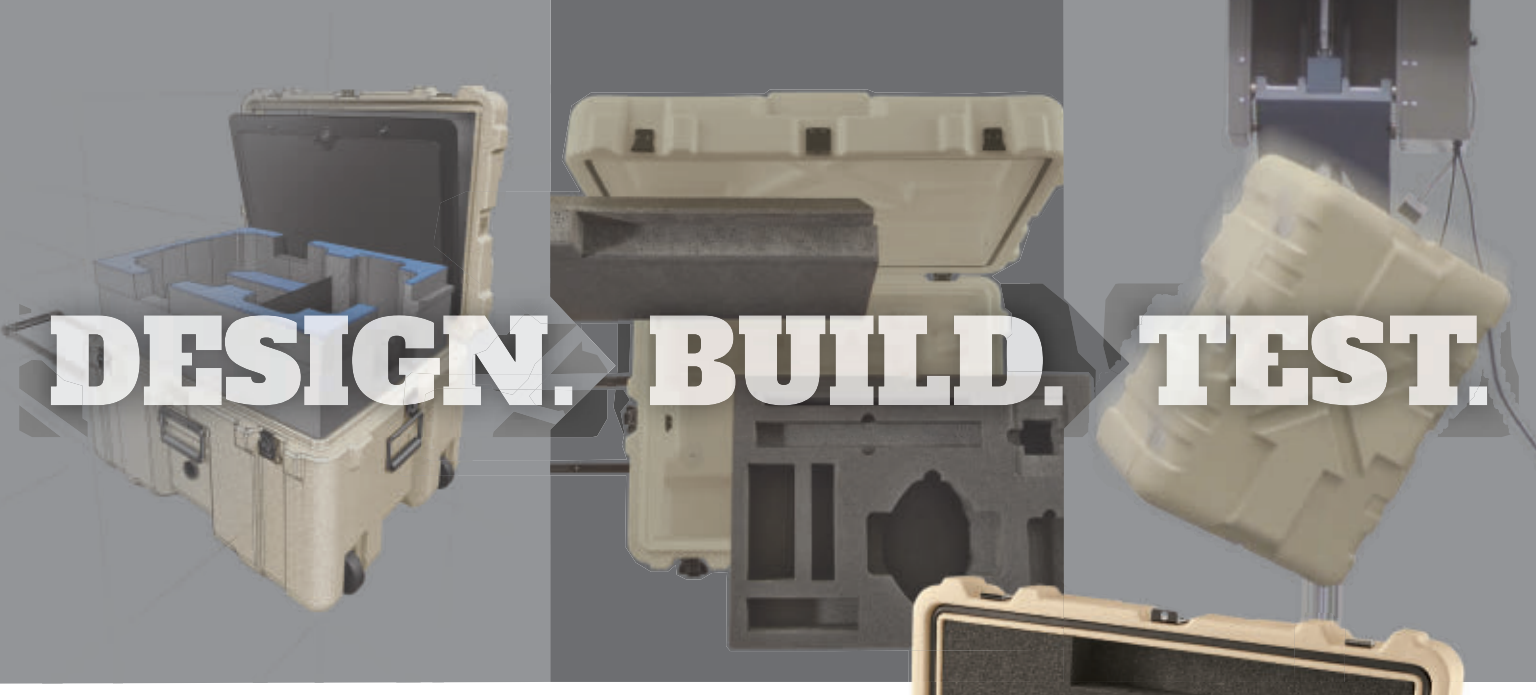

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